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## ORIGINAL ARTICLES

# AN EXPERIMENTAL STUDY IN EXCLUSION (FUNCTIONAL) OF THE PYLORIC ANTRUM.

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My problem is not to determine the relative values of pyloric obstruction and exclusion of the pyloric antrum, but to study the latter, which involves a class of cases—ulcers of the stomach, away from the pylorus—in which the results of simple gastroenterostomy are relatively unsatisfactory; cases in which resection would seem indicated were it not for the fact that chronic perforation into liver, pancreas, or other important neighbors make it a hazardous procedure. I have excluded the pyloric region twenty-seven times on the human subject, as reported at the 1914 meeting of the American Medical Association. The first fifteen patients were operated upon by transverse section of the stomach with blind closure, as first suggested by Doyen, with which no other method has been definitely proved experimentally to compare in efficiency. These experiences convinced me that the technical difficulties and dangers attendant on this procedure warranted experiments, which are reproduced herewith, looking toward a simpler and safer method which could guarantee the same result. Ten of my last twelve patients had the pyloric antrum excluded by original methods, which I shall here show to have been satisfactory on dogs.

A large number of methods have been proposed for obstructing the pylorus and excluding the pyloric region. They will be considered together, since it is difficult to separate the two historically, although they are by no means to be considered a clinical entity.

Berg[1] has practised gastro-enterostomy with pyloric exclusion since 1901 on bleeding ulcers in the pyloric region, for duodenal fistula or accidental wounds of the duodenum, and for simple or callous ulcers of the pyloric end of the stomach. His operation consists of a gastro-enterostomy in the usual manner, with the addition of an occluding ligature of heavy Pagenstecher thread passed behind the stomach just proximal to the antrum; then taking a few stitches through the peritoneum and muscularis to prevent slipping, he slowly ties the ligature, being careful not to interfere with the circulation. He says this method of exclusion does not increase the mortality or the length of the operation. Pool[2] reoperated a case upon which a gastro-enterostomy had been performed six months previously without relief of symptoms. A simple ligation of the pylorus with catgut suture was considered the safest procedure and gave a good result. He excluded a second case in a similar manner and a gastrojejunostomy was done with a satisfactory result, but he says the permanency of this closure is doubtful. Momburg[3] treated two cases by tying silk ligatures tightly around the pylorus and suturing omentum in the furrow thus created. Corner[4] says that when doing a gastro-enterostomy for pyloric ulcers he excludes the pylorus by placing a ligature on the pyloric end of the stomach as suggested by Berg. Renton[5], surgeon of the Western Infirmary of Glasgow, says the operation they have usually performed during the last three years is the posterior gastro-enterostomy of Robson, with exclusion of the pylorus, where necesssary, with a purse-string suture. Ward[6] gives a case after the Berg method, with a good result. Parlavecchia[7] merely throws a strong non-elastic ligature around the stomach at the point where the incision would be made by the usual technique, as proposed by Doyen, and proliferation of cicatricial tissue soon shuts off the part completely. On dogs it required only from two to four minutes longer than a simple gastro-enterostomy. As far as we can learn no exhaustive series of animal experiments have ever confirmed these results. The universal experience with ligatures on hollow viscera has been that they cut through into the lumen and are passed out with other intestinal contents, the peritoneum speedily becoming agglutinated outside of the constriction.

Leriche[8] tried ligating the pylorus of the human subject with catgut, and though the immediate results were good the Rœntgen rays soon showed the operation to have been a complete failure. He then did the Doyen exclusion on the same patient, with complete success. In a second case he tied a silk string around the stomach in such a way that it was divided into a small cardiac cavity and a larger pyloric one, but Rœntgen rays soon demonstrated the reëstablishment of the viscus. There was a time when Ochsner thought he had definitely excluded the pylorus by wrapping a silver wire about it. Brewer[9] uses a strip of aluminum, 1 cm. wide and 5 cm. long (thickness not stated), which is passed under the pylorus and rolled together with the fingers tightly enough to close its lumen without devitalizing the tissue. Nine dog experiments are recorded after gastro-enterostomy had been done. In all of these cases where the animal lived more than nine days the band was found hidden by new tissue and the vicinity was usually free from adhesions. There was never a necrosis, and the lumen was non-patent in every instance. No dog was allowed to live more than two months and ten days after the operation. Wilms[10] separates a strip of fascia from the anterior aspect of the rectus muscle or from the fascia lata and throws it around the pylorus, tying or suturing it so as to exclude the pylorus completely. It is easy, safe, and shortens the operation for exclusion, giving no reflex disturbance of the stomach. When we visited Professor Wilms at his clinic in 1912 he stated that Rœntgen-ray examinations of patients, some months following operation, show the pylorus to be closed. Kolb[11] practised exclusion of the pylorus by ligating with a strip of fascia or omentum in cases of bleeding ulcer of the stomach with duodenal stenosis. He treated in all 18 cases, 3 with the omentum and 15 with fascia, 9 cases were reëxamined, the pylorus found to be closed, and the chyme passing through the new opening in one hour. Technique: the strip of fascia lata is about 3 cm. wide, free of all fat and muscle. It must not be tied too tightly and the strip does not relax if sutured to the serosa with silk or catgut.

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[1] Jour. Amer. Med. Assoc., March, 1913.

[2] Ann. Surg., November, 1913.

[3] Zentral. f. Chir., October, 1913, No. 42.

[4] Lancet, London, 1913.

[5] British Med. Jour., April, 1912.

[6] Lancet, London, July 7, 1906.

[7] Policlinico, Rome, April, 1910, xvii.

[8] Lyon Chirurg., 1913.

Bircher[12] has done Wilms' operation, but is convinced that the strip of fascia undergoes early absorption. He found that strings of linen or catgut wrapped around the viscus accomplish the same result, but are not permanently effective. In 15 cases Bircher took the hepatico-umbilical ligament, cut it loose from the abdominal wall, finding it to be from 5 to 6 cm. in length, wrapped it once or twice, as the length permitted, around the pylorus, and fastened it in position with a few stitches. Rœntgenoscopy from one-fourth to one year after operation shows that the obstruction is lasting.

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[9] Surg., Gyn., and Obst., vol. xviii, p. 145.
[10] Deutsch. med. Woch., January 18, 1912.
[11] Deutsch. chir. Kong., 1913.
[12] Zentralbl. f. Chir., October, 1913, No. 40.

Hercher[13] had four cases in which he excluded and suspended the pylorus (after gastro-enterostomy) with the ligamentum teres hepatis. Hoffmann[14] uses the same method with the ligamentum teres hepatis. Polya[15] thinks that the closure of the lumen thus is the only safe means of exclusion. He thinks in the ligamentum teres hepatis he has found a material which, on account of its form and suppleness, is even better for the purpose than the strip of fascia used by Wilms. He had seven cases, of which five were successful. Gobell[16] excludes the pylorus after the Wilms method. Naselli[17] has proved in six animal experiments that it is impossible to exclude the pylorus by ligature method. His ligature consisted of an aponeurotic band from the fascia lata, from the anterior abdominal wall, or the tendon Achilles. In no case did he get the permanent physiological result desired. He did secure slightly more stenosis in instances where he first crushed a furrow with forceps and then tied his strand in this. In no case did the tissue ligature cut into the lumen. In the beginning the lumen is closed by longitudinal folds of mucous emmbrane but later there is an atrophy of the encircling tissue, the folds straighten out, and the canal is reëstablished. In consequence of this a gastro-enterostomy made at the same time as the ligation will eventually close up if the animal lives long enough. Surely the autoplastic method of obstructing the pylorus has a distinct advantage if as is claimed the fibrous band remains viable. It is said to become firmly adherent to the peritoneum and hence does not cut its way into the viscus. The permanency of these results must, however, remain an open question until experimenters have had time for most remote observations. Blad[18] discusses the methods in vogue for closing the pylorus in a gastro-enterostomy, and reports a case in which he folded in the pylorus and duodenum with silk sutures, forming a role about 6 cm. long and as thick as the little finger. Examination seven months later showed most of the chyme expelled through the new opening, but also part through the pylorus. Mertens[19] kinks the pylorus by sewing together the anterior surfaces of the stomach and duodenum, attempting in this way to obstruct the lumen. He had four cases, two of which were examined at the expiration of seven weeks and the pylorus found to be obstructed. He admits that an examination after a much longer time is necessary to determine the permanency of closure. Sequinot[20] shows the inefficiency of a gastro-enterostomy in all cases where a true stricture of the pylorus does not exist, and after showing the advantages of exclusion gives a procedure of infolding. He gave three cases, two of which were successful. Mariani[21] did an exclusion in this way: the stretched pylorus was kinked on itself and sutured to the duodenum and below to the rectus muscle and subcutaneous tissue. Functional results were good at once. He[22] later reports two cases, the first one dying of pneumonia and the second giving a good functional result. The Rœntgen rays showed food passing through the gastro-enterostomy, but he does not state how long after operation. It is pretty well established that no form of infolding or kinking has more than a temporary effect in producing occlusion.

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[13] Zentralbl. f. Chir., August, 1913, No. 44.

[14] Ibid.

[15] Ibid.

[16] Ibid.

[17] La Clinica Chirurgica, May, 1913.

[18] Ugesk. f. Læger, 1912, xxv.

[19] Zentralbl. f. Chir., October, 1913, No. 40.

[20] Thèse de doct., Paris, January, 1913.

In 1893 Doyen[23] was probably the first to suggest exclusion of the pylorus when he reported to the French Surgical Congress that he had in two cases done this for ulcer by cutting across the stomach just proximal to the pyloric antrum and making a blind closure of the resulting ends. Von Eiselsberg[24] independently proposed exclusion of the pylorus in 1895, reporting two cases of pyloric cancer in which adhesions made resection impossible. The intense pain which had been a leading symptom in both cases was completely relieved and, as a matter of course, the operation goes by his name in all German descriptions of it. Haberer[25] has done twenty-four exclusions, using the Doyen-von Eiselsberg technique. All the patients are well today but two, one of whom died of jejunal ulcer and a second who was reoperated for the same. He thinks this the operation of choice for duodenal ulcer, and it can take the place of difficult technique in benign cases. It is indicated in perigastritis of the pyloric region, and it should guard against cancerous degeneration of the ulcer. Threatened perforation may also be prevented. Jonnesco[26] in 1906-07 operated upon nine cases of pyloric and duodenal ulcers after this method of Doyen-von Eiselsberg. Jianu[27] discusses the advantages of exclusion and gives a report of two cases operated upon after the method last mentioned. Girard[28] says in cases of duodenal ulcer the operation is usually incomplete without an exclusion of the pylorus. If the employment of Doyen's method is impracticable he recommends a separation of the seromuscular layers and the introduction of a longitudinal suture. In greatly exhausted patients he uses a plicature of the anterior wall of the stomach or ligation as indicated by Körte. He gives two cases of partial exclusion by means of several plications of anterior wall. Leriche and Bressot[29] review fifty-nine exclusions of the pylorus and duodenum. By exclusion of the duodenum they mean cutting the pylorus across and closing each stump, finishing with a gastro-enterostomy. The operation for exclusion of the pyloric antrum is more difficult being on the stomach tissue itself. All results were good with no deaths. Leriche[30] says all procedures intended to exclude the pylorus, excepting those which cut the stomach in two, may be regarded as parodies on surgery. He has done three exclusions of the duodenum by means of a modified Doyen operation at the pylorus, cutting across the sphincter, and he states that this is extremely easy, takes but a few sutures, and requires not over ten minutes for its performance. Jianu and Grossman[31] review the history of exclusion of the pylorus and also give results of experiments on dogs. They conclude that vacuolar degeneration of the excluded stomach mucosa rapidly procedes and favors healing of ulcer, also wards off hemorrhage, perforation, and cancerous degeneration later. Küttner[32] says in the surgical treatment of duodenal ulcers that the ideal method is that of gastro-enterostomy with the Doyen-von Eiselsberg method of unilateral exclusion of the pylorus, but the operative mortality is increased 10 per cent. He also uses Wilms' method, with a strip of fascia or Bier's method of crushing. Von Tappeiner[33] experimented on seventeen dogs in comparing results of the following five procedures to occlude: (1) infolding by suture; (2) narrowing the pylorus by what is called submucous plastic (this means manipulation of flaps formed of mucularis and serosa); (3) ligation of the pylorus with foreign material; (4) ligation of the pylorus with a pedunculated strand of serosa and muscle from the anterior abdominal wall; (5) ligation of the pylorus with strips of fascia after Wilms' method. He lost but one animal and examined all the others four, seven, or ten weeks later. As a result of these experiments he concludes that none of the five compare in efficiency with transverse section of the stomach as done by Doyen. Of these five methods, however, Wilms' ligation with a strip of fascia seem to be most efficacious. The great argument against Doyen's idea is the difficulty of execution.

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[21] Policlinico, Rome, August 17, 1913.

[22] Zentralbl. f. Chir., November, 1913, No. 44.

[23] Französicher Chiro. Kongress, 1893.

[24] Arch. f. Klin. Chir., Band 50, 1895.

[25] Ibid., 1913, Band. 100, Heft 1.

[26] Revue de Chir., 1907.

[27] Wien. klin. Woch., 1910.

[28] Verhand. d. deutsch. Gesellsch. f. Chir., Berlin, 1911.

[29] Lyon Chir., Lyon, October, 1911, Band. vi.

The question of pyloric exclusion was discussed at a recent meeting of the Deutsche Gesellschaft in Berlin. Some were in favor of it, especially von Eiselsberg, others, including Kocher, think the methods without exclusion give the best results, but no conclusion was reached.

All my dog work was done under full ether anesthesia, every care being given to the animal's comfort later.

It may not be out of place before reciting the details of my experiments to state in a general way the method of studying the material secured. As soon as possible after death the stomach together with lower esophagus and upper jejunum were removed

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[30] Lyon Chir., Lyon, October, 1913.

[31] Arch. f. Verdauungskr., April, 1910.

[32] Deutsch. chir. Kong., 1913.

[33] Beitr. z. klin. Chir., 1912.

*en bloc.* These viscera were distended with water until normal roundness was maintained, double ligated, and then hardened in 4 per cent. formalin solution. Some days later they were emptied, injected with barium, and rœntgenograms made. These together with illuminating diagrams are shown in Figs. 5 and 16. Transverse section was next made across the stomach on both sides of the septum and very close to it. After study of this interesting object in its entirety it was cut into thin transverse sections, of which one is shown herewith (Fig. 17).

Experiment I. December 19, 1912; large brown collie. We made a two-inch posterior no-loop gastro-enterostomy. There was a tear through the omentum, which was repaired.

February 7, 1912, the dog was killed because of distemper. The autopsy showed the gastro-enterostomy to be patent and there were no macroscopic lesions of the bowel or peritoneum. This was a control operation.

Experiment II. April 17, 1911; a small white and black fox terrier bitch. The pyloric region was excluded by mattress sutures including four thicknesses behind a transverse clamp, through which pressure was applied across the stomach for fifteen minutes. An anterior row of peritoneal sutures covered up the mattress row. An anterior gastro-enterostomy was done.

October 25. The dog was sacrificed and the gastro-enterostomy found to be patent. A white scar ran across the anterior and posterior surfaces of the stomach just distal to the gastro-enterostomy opening at the point where the clamp had been applied. There was no change in the stomach lumen. Distal to the cross-scar the outer surface of the stomach had a yellowish tinge and the mucous membrane was deeply bile-tinged over the corresponding area.

It had been thought possible to crush through the mucosa and cause an agglutination of the deeper mesoblastic structures, these being held in approximation by the mattress sutures. The futility of this plan was strikingly shown at autopsy some six months later; in fact the stomach showed but slight evidence of operative interference.

Experiment III. Januray 27, 1912; small black slut. At a distance of about two inches from the pylorus a slender rod was inserted under the stomach, lifting it up, and a clamp applied beneath. A transverse incision was made down to the muscularis of the posterior wall. The submucosa and the mucosa were cut as short as possible and allowed to retract. The anterior and posterior muscularis and serosa were drawn together by interrupted sutures, which were then hidden by a Lembert layer. The operation was finished by a posterior gastro-enterostomy.

February 2, the dog died. The belly was full of thin fluid blood and the intestines were matted around the pylorus. A furrow transverse to the stomach and about 3 cm. from the pylorus indicated the site of the exclusion. A longitudinal section showed a complete septum formed by a double layer of the anterior wall attached to the posterior wall without intervention of the mucosa.

EXPERIMENT IV. February 17. This is a repetition of Experiment III. February 24, 1913, the dog died. The autopsy showed the belly full of bloody pus, the stomach was small, and the upper intestines engorged with bile. A deep groove on the anterior and posterior walls showed the site of the obstruction to be about 3.5 cm. from the pylorus; on section a complete septum was seen, two-thirds of which was formed by all the layers of the anterior wall. The gastro-enterostomy was found to have been made in the transverse colon.

The last two experiments prove only one thing, namely, that the simple method used is entirely too dangerous to be considered further. Both dogs died of peritonitis on the sixth and seventh days respectively. A complete septum was found in each case; however, the period of observation is too short to establish its permanency.

EXPERIMENT V. January 6, 1912; small white dog with bronze head. We incised the anterior wall of the stomach to the submucosa, both layers of which were divided transversely without wounding the posterior muscularis, the proximal and distal submucosa being closed blind. The anterior serous and muscular coats were sutured with two rows and the operation was completed with a gastroenterostomy. Result: the dog was lost. The foregoing experiment represents a development of technique tending in the direction of greater safety. It is to be regretted that the result is not known.

EXPERIMENT VI. January 17; small black dog. At about three inches from the pylorus the wall was cut transversely to the submucosa, which was separated from the muscularis all the way around and the latter divided transversely. Both ends of the submucosa were then closed blindly and the muscularis and peritoneum sewed so that the anterior and posterior wall layers came together between the ends of the blind submucosa.

February 4 the dog died. The stomach and loop for the gastroenterostomy were found to be greatly dilated. There was an obstruction and the stomach contents were found in the esophagus. The peritoneum was clean. At a point 3 cm. from the pylorus, furrows on both walls were external evidence of the site of the exclusion. A longitudinal section revealed a complete septum formed by a double layer of the anterior and posterior stomach walls, meeting end on without intervention of the mucosa.

EXPERIMENT VII. January 20, 1913; small white bitch. This is a repetition of Experiment VI, with the single exception that the incision in the anterior wall through the serosa and muscularis was made in the long axis of the stomach and quite near the pyloric region, on either side of which the submucosa was sewn blind.

EXPERIMENT VIII. February 24, 1912. This is an exact replica of Experiment VII. March 9. The dog was healthy, so was killed with chloroform. The exterior of the stomach showed little effect of the effort to obliterate the lumen. There was an incomplete septum seen on section.

In Experiments VI, VII, and VIII a technique based upon accepted surgical principals was devised, with the result that no dog died directly in consequence. One was killed on the fourteenth day while the other two died on the fifteenth and eighteenth days respectively. In the last two mentioned a complete septum was found, while in the fourteenth day animal it was only partially in evidence. While this form of exclusion is apparently leak-proof (in three instances at least) it is not satisfactory so far as simplicity and neatness are concerned. It is the identical operation which was described later by Porta[34] as having been adopted at the Biondi clinic. I had done this some months before his article appeared, but discarded it for the reasons given.

EXPERIMENT IX. February 10, 1912. A rod was passed transversely under the stomach and the lifted portion was caught in clamps. A shoemaker stitch was placed between the rod and clamp and everything cut through onto the rod. After cutting away the redundant mass the whole was inverted with Lembert sutures and a gastro-enterostomy done as usual.

February 17 the dog died. The stomach was dilated and an intussusception was present in the small intestine. A deep furrow on the anterior and posterior walls indicated the site of the infolding. A heavy complete septum was formed equally from both anterior and posterior walls; no mucosa intervened between the other tissues.

EXPERIMENT X. February 3, 1912; small white bitch. This experiment repeats Experiment IX, although the mattress stitches were introduced in a slightly different manner.

The animal died March 4. There was great dilatation of the stomach. A furrow on the exterior marked the site of the operation and a fine mucosa-lined canal persisted. Judging by the amount of dilatation there must have been a high degree of partial obstruction.

The same principle is involved in the two experiments just described, though the technique differed somewhat One animal died in seven days without any evidence of a leak, while the other lived thirty days. The septum was practically complete in the last-mentioned animal, while the other lived too short a time to be of value in this regard. Too much hemorrhage at the minor curvature characterized these operations.

After the foregoing ten experiments had been made a clinical experience suggested to the writer that partial transverse division of the stomach might be sufficient to create complete functional exclusion of the pyloric region. It came about in this way: A large callous ulcer was widely excised from the minor curvature, the stomach being cut about half way across, and in closing the defect the wound sutured transversely to the long axis of the viscus. Still complete obstruction ensued and was relieved only when a gastro-enterostomy was done some days later. At the second operation no mechanical explanation could be elicited, the stomach lumen being unimpaired (I am told by Dr. William J. Mayo that this phenomenon has appeared so often at Rochester that he does an immediate gastro-enterostomy whenever a large excision of the lesser curvature is made).

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[34] Deutsch. Zeit. f. Chir. Bd. 125, No. 5-6.

The ensuing twenty-eight studies are based upon the idea of a functional disturbance or at just distal to a partial transverse incision through both stomach walls (as opposed to the complete transverse incision of Doyen-von Eiselsberg). In addition I have created a partial septum in each instance while closing the defect.

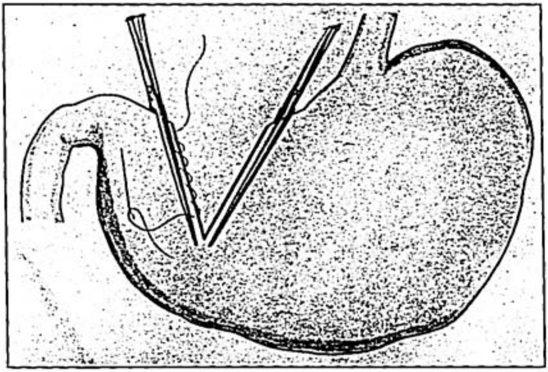

FIG. 1.—Clamps have been placed two-thirds of the way across the stomach at the minor curvature; both walls cut between them and a whip stitch partly introduced.

EXPERIMENT XI. December 24, 1912; a small dog. A transverse incision was made into the minor curvature half-way across the stomach between two clamps (Fig. 1) which had been placed about one-fourth of the way from pylorus to cardiac. A shoemaker's stitch was carried clear across behind the clamps closing the wound and then two rows of mattress sutures (Fig. 2) were applied in such a way that a septum was established as the first row was entirely hidden.

March 24, 1913, the dog died. In the minor curvature and extending almost across the anterior and posterior walls of the stomach was a deep furrow which practically cut off the pyloric portion from the rest of the viscus. This first named was shrunken to less than one-fourth of its original dimensions. Contraction of the deep scar in the minor curvature had led to the pylorus approaching the cardia to a considerable extent. Viewed from either side the septum appeared to be complete. Water could not be poured through it and its centre presented a uniformly smooth appearance no matter from which side it was viewed. It measured 3 cm. from the greater to the lesser curvature and a mucous-lined canal at the greater curvature was seen completely collapsed, probably due to the cicatricial band around it. Had dilatation been possible it would probably have admitted a rod almost 1 cm. in diameter.

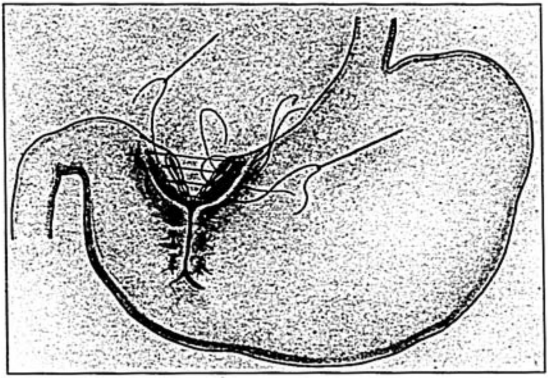

FIG. 2.—Mattress stitches cover the first row in front and behind.

No practical use can be made of this result, however successful it may have been, since the minor curvature furnishes a comparatively inaccessible and very vascular field. However, the lower border of the viscus is open to neither of these objections and will be used in future experiments of this kind.

EXPERIMENT XII. January 8, 1913; medium sized white half bulldog. A deep cut (Fig. 3) was made into the greater curvature just proximal to the pyloric antrum and a whip-stitch made outside of both clamps. The first row was then inverted by a Lembert row (Fig. 4), leaving a defect, and a posterior gastro-enterostomy was done.

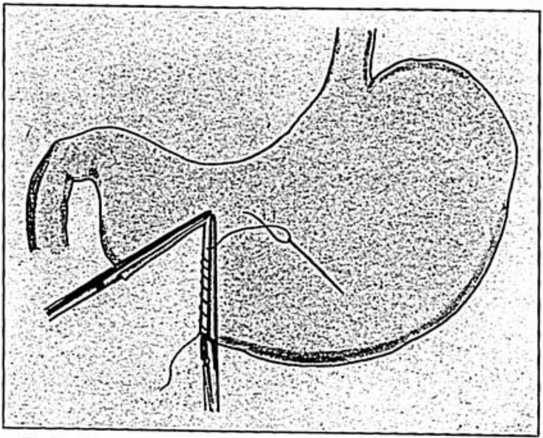

FIG. 3.—The stomach has been divided two-thirds of the way across at the greater curvature and the resulting defect partly closed blind.

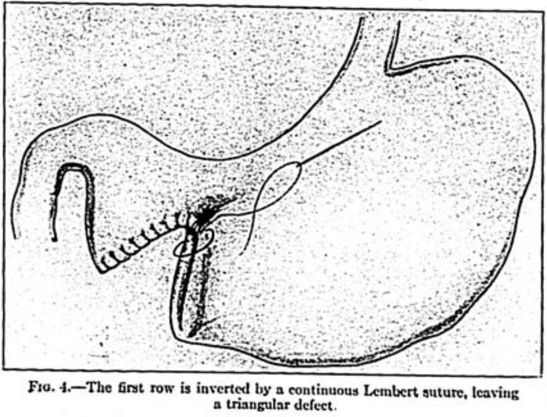

FIG. 4.—The first row is inverted by a continuous Lembert suture, leaving a triangular defect.

January 20 the dog died. There was no peritonitis but great emaciation, a moderate dilatation of the stomach, and also a dilatation of the jejunum below the gastro-enterostomy opening. The heart muscle was flabby. A deep furrow on the anterior and posterior surfaces showed the new septum. There was practically no distortion or change in either segment and the organ looked very much as it did when it was dropped back into the abdomen at the completion of the operation. Viewed from either side the septum measuring 3⅓ cm. from the greater to lesser curvature, was entirely covered with mucous membrane excepting just under the minor curvature, where it was perforated by a mucous-lined canals maller than a goose-quill in size, which when split lengthwise and spread out was lined by folds of mucous membrane and appeared slightly larger than before it was cut.

Experiment XIII. January 20, 1913; a small white slut with a yellow head. This is an exact repetition of Experiment XII.

April 2 the dog died of distemper. The stomach was quite large and a deep furrow clear around it demonstrated the position of the new partition. The specimen gave the impression of intestine springing from the stomach wall as is the case where an end-to-side anastomosis has been made. Postmortem rœntgenoscopy showed bismuth making use of the new opening instead of the excluded pyloric portion. Viewed from the stomach side the septum, measuring 3¾ cm. from greater to lesser curvature, appeared to be absolutely complete and bulged well forward into the cavity of this viscus. There was a mucous-lined canal tightly folded together, through which a lead-pencil might be forced were the walls of the canal not so rigid.

Experiment XIV. February 12, 1913; a medium sized black animal. This repeats Experiment XII.

February 15 the dog died. The autopsy showed acute purulent peritonitis, the exclusion suture line leaking when water was forced into the specimen. There appeared to be a complete septum, although it was impossible to harden the specimen injected with the walls on tension on account of the leak. It is only fair to state in connection with the death of this animal that an experimental intestinal anastomosis was carried out with what seems to have been faulty technique after completion of the stomach work.

Experiment XV. April 10, 1913. This is exactly the same as Experiment XII.

August 30. A rœntgenogram, with bismuth in the stomach, demonstrated the absence of the pyloric portion and the mixture escaping only through the gastro-enterostomy opening.

September 4. The dog well nourished and playful, was killed with chloroform. A deep groove on the anterior and posterior surfaces represented the plane of the new septum, distal to which the stomach was shrunken in a most interesting manner. It was not to be distinguished in appearance or size from the duodenum which was extremely pale and shrunken.

Postmorten Rœntgen ray findings: The accompanying roentgenogram (Fig. 5) shows the septum to be complete and bismuth, leaving the stomach only through the gastro-enterostomy opening.

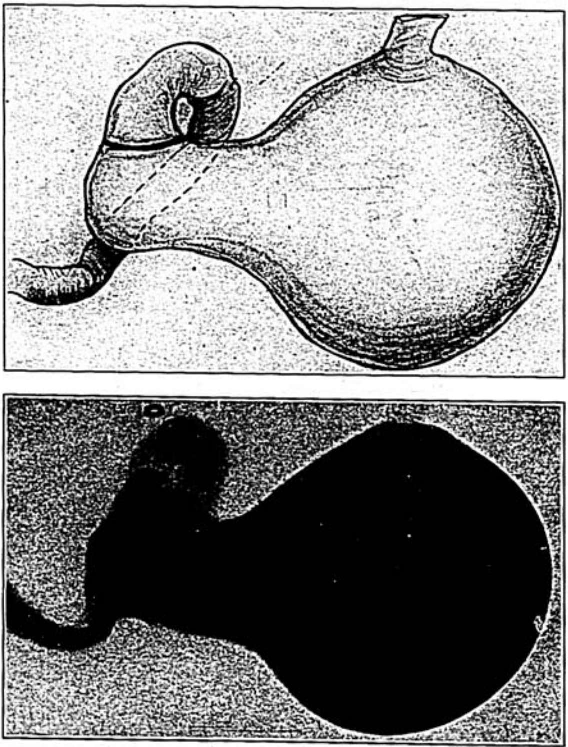

FIG. 5.—Illustrates the postmortem Rœntgen-ray appearance of the stomach in Experiment XV.

Viewed from the stomach side the septum from greater to lesser curvature measured 3.5 cm. and appeared to be absolutely complete.

A short double heavy suture hung from the centre and was surrounded by concentric folds of mucous membrane. There was a mucous-lined canal through which a goose-quill might have been introduced if only the surrounding ring of scar tissue could have been stretched.

Since only one of the last-mentioned four stomachs leaked it may be justly inferred that the operation rather than the method is to be blamed. No cause can be assigned for the death at twelve days, nor will any attempt be made to draw a conclusion so early. The specimens recovered after the animals had lived about three and five months respectively demonstrated anatomically the efficiency of the procedure as was done functionally by Rœntgen rays in the animal (Experiment XV) which lived longest.

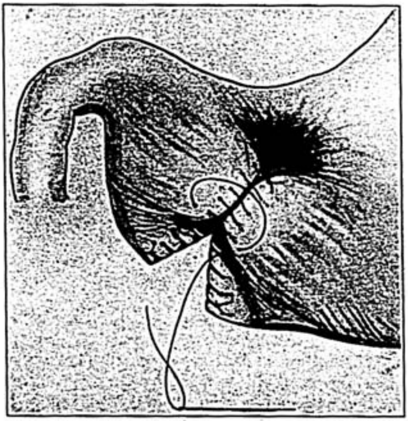

FIG. 6.—Here a defect, similar to the one made in Fig. 3, is closed blind by an inner through-and-through stitch, which is inverted by a continuous Lembert row down the front and up the back.

EXPERIMENT XVI. January 18, 1913; small slender white slut. An incision was made into the greater curvature, the clamps were separated, and a running stitch was taken clear across outside of both clamps. These suture lines were held together and a continuous Lembert suture (Fig. 6) was carried around them down posteriorly and up anteriorly. This inverted a septum and restored the external appearance of the stomach. Approximately the pyloric one-quarter of the stomach was excluded. The operation was finished with a posterior gastro-enterostomy.

March 10. No cause could be found for the death of the dog. It was emaciated but showed no peritonitis, adhesions, or obstruction. A faint furrow extending clear around showed the presence of the septum in this instance. The excluded portion was so shrunken so far as diameter was concerned, that it closely resembled the small bowel which served as its continuation. The septum, measuring 2 cm. from greater to lesser curvature, appeared to be absolutely complete when viewed from the stomach side, and was covered with deep folds of mucous membrane. A fine canal completely lined with mucosa penetrated the septum at the lesser curvature.

Experiment XVII. January 24, 1913; slender white, yellow spotted fox terrier. This is a complete repetition of Experiment XVI.

February 8 the dog died, but no cause was revealed by the autopsy. There were practically no adhesions about the visceral wounds, no obstruction and no peritonitis. The location of the septum was clearly defined by a groove running entirely around the organ, the excluded portion being considerably shrunken, although retaining its normal outlines. Seen from the interior of the stomach the septum, which measured 3 cm. from the greater to the lesser curvature, appeared to be complete and bulged markedly into the stomach cavity. Water could not be poured through it and no opening could be discovered by dissection of the septum.

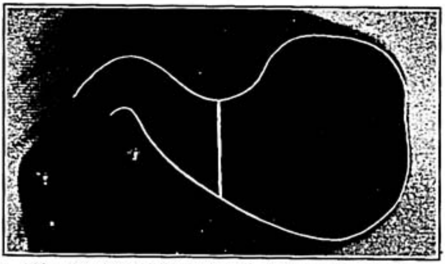

Fig. 7.—This rœntgenogram was taken in life seven months after the operation and shows the pyloric region to have been practically cut off.

Experiment XVIII. February 3, 1913; small white fox terrier bitch. This is a duplicate of Experiment 16.

August 30. A Rœntgen ray test (Fig. 7) showed the pyloric region to be excluded, bismuth running out only through the new anatomatical opening.

September 4. The dog, well nourished and in good spirits, was killed with chloroform and the atuopsy revealed faint adhesions from the exclusion line to the under surface of the liver. The peritoneum was otherwise apparently normal. A deep furrow in the anterior and posterior surfaces represented the exclusion line, the excluded portion being shrunken to a point where it represented not more than one-fifth of the stomach's total cubic capacity. Viewed from the interior of the stomach the septum, from greater to lesser curvature measuring 3 cm., appeared to be absolutely complete, with folds of mucous membrane radiating from the centre of the same and a thread four inches long hung free by one end in the stomach cavity. If an opening existed it could not be found by dissection of the septum.

EXPERIMENT XIX. February 21, 1913; small black slut. This experiment is an exact replica of Experiment XVI.

On March 8 the dog died. There was no sign of obstruction or peritonitis. The septum looked just as it did at the time of operation.

EXPERIMENT XX. March 1, 1913. The technique here was carried out identically as in Experiment XVI.

March 17 the dog died. Autopsy showed no peritonitis nor obstruction. A very deep furrow particularly on the posterior wall marked the site of the artificial partition. There was considerable rotary distortion of the stomach, although comparatively little deformity had taken place otherwise. Viewed from the stomach side the septum, measuring from greater to lesser curvature 4.5 cm. in length, was almost complete. At the minor curvature was a mucous lined canal barely large enough to admit a ray of light, but through which water could not be poured. A lead-pencil might have been forced through were it not for scar thickening of its wall.

In Experiments XVI to XX inclusive an anatomical result was intended and obtained similar to that characterizing the group which preceded them. The technique of producing the septum was slightly different in the two sets of experiments. None of these last five animals was lost as a result of peritonitis or obstruction; three died at the end of fifteen, fifteen, and sixteen days respectively. Although no cause could be determined at autopsy, death occurred too early to permit of conclusions being drawn. Two stomachs were recovered at the expiration of about two and seven months respectively, both showing what is now regarded as a characteristic shrinkage of the excluded portion. The Rœntgen rays proved before death that the seven months' stomach possessed no functionating pyloric portion.

EXPERIMENT XXI. January 4, 1913; Medium-sized black, short-haired slut. We made a cut into the greater curvature at the usual distance from the pylorus, then made a whip-stitch outside of the clamps, and everted all four layers by mattress sutures (Fig. 8). The peritoneum was then whipped over all and a no-loop posterior gastro-enterostomy done. The stomach, as viewed from the exterior, was entirely reëstablished, leaving a septum.

March 1 the animal was sacrificed because of the mange. No peritoneal involvement was found. The gastro-enterostomy was patent. Very deep infolding on the anterior and posterior walls of the stomach showed where the partition was made. The excluded portion was considerably shrunken and was distinctly paler in color than the rest of the viscus. The septum, which measured from the greater to the lesser curvature 5 cm., presented an opening at the minor curvature about the size of a lead-pencil. It was a mucous-lined canal through which water could easily be poured.

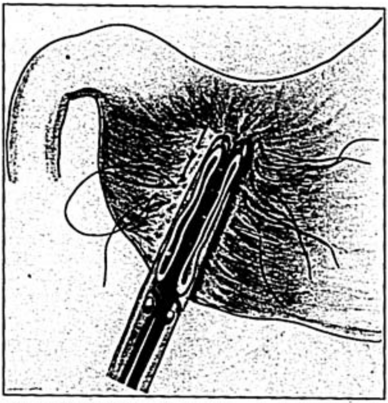

FIG. 8.—A defect similar to that in Fig. 3 is being closed with through-and-through mattress sutures; these will be inverted by a continuous Lembert row.

A septum similar to the nine which preceded it was produced in a slightly different manner in Experiment XXI. The result seems to have been anatomically all that one could desire if permanent conclusions can be drawn at the expiration of two months.

Experiments XI to XXI inclusive were all made by cutting into the greater curvature except the first, which involved the minor curvature. Ten septa have been excised and examined as to complete closure. Of these, seven were found to extend practically across the lumen of the stomach, which is all the more surprising when one considers that no complete operation was attempted. Each of the other three presented appreciable mucous-lined canals just where one had been left at the operation. In one instance this was large as a pencil, in the second as large as a goose-quill and in the third merely large enough to admit a ray of light. Specimens were examined at the expiration of three, fifteen, fifty-two, seventy-two, ninety, one hundred and fifty, and two hundred ten days respectively.

Rœntgen-ray determinations in Experiments XI to XXI inclusive prove that partial transverse section of the stomach results in complete functional exclusion of the pyloric region in addition to extreme shrinkage of the same. In accomplishing this we have up to date cut through either the minor or major curvature with consequent danger of hemorrhage from the large vessels which are necessarily encountered. As a natural step in the evolution of the method we commenced with No. 22 to use an incision similar in length, location, and general direction to that employed in the preceding eleven animals, but so placed across the axis of the stomach that it interrupted the lumen without involving the region of either curvature. This procedure was employed in Experiments XXII to XXXVI inclusive.

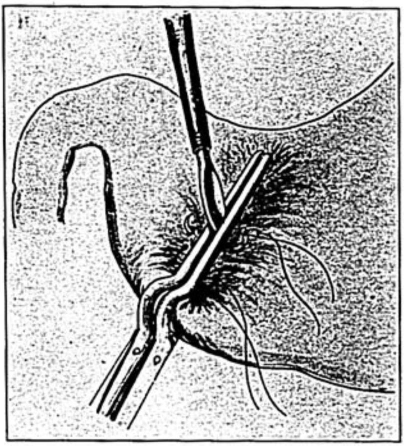

FIG. 9.—The clamps leave both curvatures free; through-and-through mattress sutures are introduced behind them, and both walls of the stomach are divided only as far as crushed.

EXPERIMENT XXII. March 4, 1913. We did a gastro-enterostomy and then placed two clamps across the stomach (Fig. 9) about one-quarter of its length away from the pylorus. The blades were so bent as to leave the greater curvature free and of a length which prevented them reaching to within 1 cm. of the lesser curvature. The viscus was then cut half-way across leaving one-fourth of it intact at either curvature. Mattress sutures taken behind the clamps, everted the cut edges; they then were hidden by a continuous Lembert suture.

August 30. No pyloric region showed in a rœntgenogram, while bismuth escaped through the gastro-enterostomy opening only.

September 4. The dog, well nourished and playful, was killed with chloroform. The excluded portion was represented by a contracted mass which represented not more than one one-hundredth of the cubic capacity of the stomach, having its boundary well defined by a deep groove on the anterior wall. Postmortem rœntgenoscopy showed the bismuth to have been directed entirely from the normal channel by the new partition. Viewed from the stomach side the septum seemed complete with one mattress stitch hanging into the lumen. The centre of this diaphgram was indicated by a deep round depression surrounded by circular furrows of mucosa. Cross-section through the middle of the excluded portion of the stomach showed its wall to be enormously thickened, contracted, and the mucosa reduced to a very small amount.

Experiment XXIII. March 8, 1913. A cut was made nearly across the stomach at its middle, using an original exclusion clamp (Fig. 10) which left both curvatures free. After five mattress sutures had been introduced behind the clamp the crushed stomach was divided through the slit in the upper blade of the instrument. The mattress stitches were tied and the row inverted with a continuous Lembert suture. An anterior gastro-enterostomy was made well to the left of the midline.

April 3 the dog died of distemper. A deep annular constriction divided the stomach into two portions, the pyloric being greatly reduced in caliber although not much effected in length. There was not even a peritoneal adhesion in the vicinity of either of the visceral wounds. A postmortem rœntgenogram is shown. An inspection of this septum showed a faint ray of light penetrating it at the greater curvature. Water did not leak through the opening and rows of deeply folded mucosa radiated from it. Two loops of thread hung free into the stomach cavity.

Experiment XXIV. March 12, 1913. This was an exact replica of Experiment XXIII except that a posterior gastro-enterostomy was done.

On April 7 the dog died of distemper. There was no peritonitis or adhesions except of the omentum to the suture lines. Deep grooves on both surfaces demonstrated very plainly where the exclusion was made. The pyloric portion was so changed in consequence that it resembled the intestine in every way, with the single exception that it was double the caliber of the viscus last named.

Postmortem Rœntgen ray findings: bismuth left the stomach only through the gastro-enterostomy opening and could not be made to pass through or around the new septum.

Viewed from the stomach or intestinal side the septum appeared to be complete, when, however, it was held to the light a small defect could be noted at the minor curvature, although water could not be poured through the same. A deep linear groove from which folds of mucosa run transversely was apparent on both sides of it.

EXPERIMENT XXV. April 12, 1913. This also was a repetition of Experiment XXIII with a posterior gastro-enterostomy.

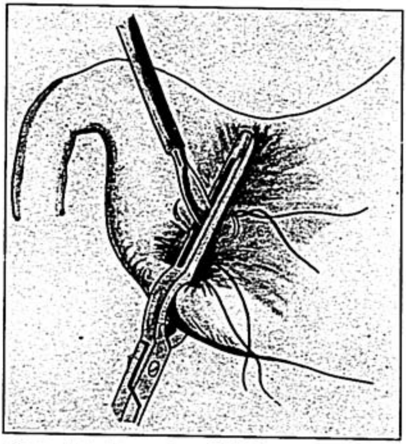

FIG. 10.—Demonstrates the use of an original clamp, which shows both curvatures free and has a slit in the upper blade through which both stomach walls are partly divided after through-and-through mattress sutures have been introduced behind it.

April 24 the dog died. It was thin and the autopsy showed no pathological condition on the peritoneum, bowel, or lumen. This stomach was very small and showed a considerable portion of it to have been excluded. The part so treated bore every resemblance to a segment of intestine, being merely slightly greater in diameter than the latter. Postmortem Rœntgen ray findings were to the effect that no bismuth passed through the pyloric portion of the stomach, but all of it followed the course of least resistance through the gastro-enterostomy opening. The septum in this instance viewed from both sides looked as though it were complete. The site of the suture line was indicated by a linear depression from which folds of mucosa radiated.

EXPERIMENT XXVI. April 19, 1913. A metal spatula was introduced through a slit in the gastrocolic ligament to protect the structures behind the stomach, then a metal "skewer" (Fig. 11)

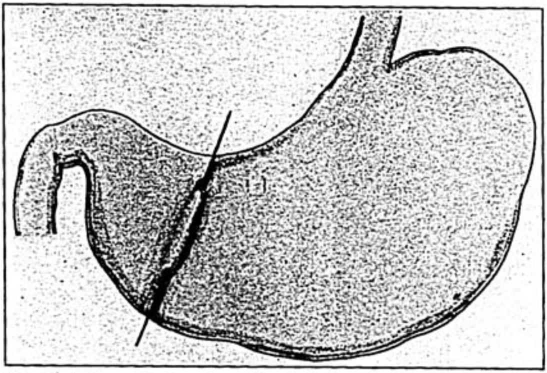

FIG. 11.—A skewer has been thrust through both stomach walls and out again; it holds them up for about half the distance across the axis of the organ.

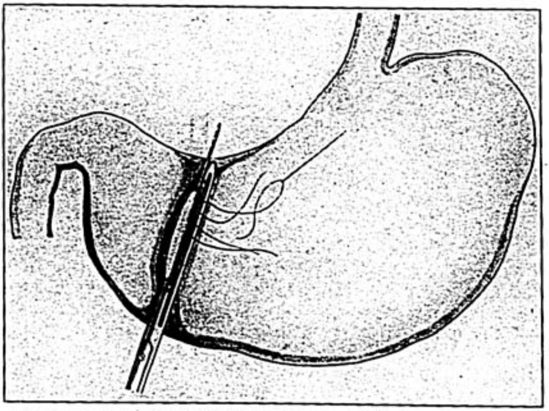

FIG. 12.—A clamp with slit blades has been placed behind the skewer, through-and-through mattress sutures having been introduced in the slit or between clamp and skewer if preferred.

was thrust directly through both walls of the stomach into the lesser peritoneal cavity and out again so as to encompass about one-half the distance between the two curvatures. A clamp (Fig. 12) was placed behind the "skewer" and several mattress sutures introduced between the "skewer" and clamp; as a matter of course these embraced the whole thickness of both walls of the stomach. The "skewer" was cut out (Fig. 13) with a sharp knife and the

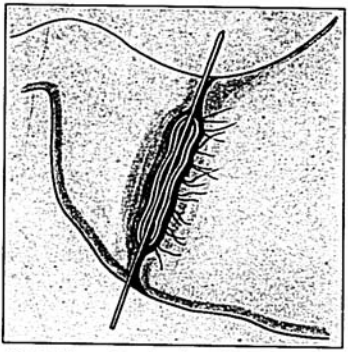

FIG. 13.—The mattress sutures have been tied and the skewer cut out.

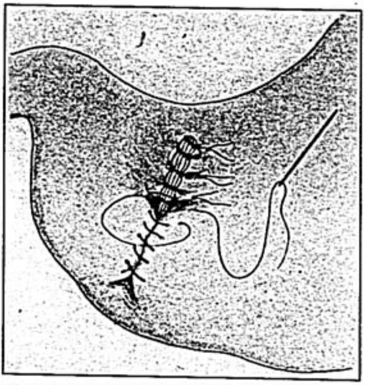

FIG. 14.—A whipover suture acts as a hemostatic and is buried by a Lembert row.

mattress sutures tied before the clamp was removed. A hemostatic running stitch of silk or linen united the four exposed cut edges (it may be inverted before removal of clamp). The ridge of tissue formed by the mattress sutures was inverted (Fig. 14) with a continuous Lembert row.

May 6 the dog died. The peritoneum was full of thin fluid blood and a few clots. There were many adhesions between the anterior wall of the abdomen, pylorus, and liver. A well-defined groove showed the presence of the artificial partition, and the excluded portion was deformed to the extent that its proximal end looked as though it had been implanted laterally into the stomach wall. The septum appeared to be absolutely complete when the gastric aspect of it was considered. Its centre was represented by a deep depression from the sides of which hung two silk sutures. It was on the intestinal side that the most marked change was noticed. The lumen of this excluded area was not greater than that of the bowel. Its muscular wall was enormously thickened and the mucosa contained within this tube was reduced to a few thin folds.

EXPERIMENT XXVII. April 22, 1913. This is exactly the same as Experiment XXVI.

May 6 the dog died, with no evidence of disease anywhere. The characteristic grooves particularly deep on the posterior aspect in this instance demonstrated the position of the new partition. The distal portion of the stomach was shrunken to the point that it bore a striking resemblance to the adjacent intestine. Postmortem Rœntgen ray examination showed bismuth leaving the stomach through the gastro-enterostomy only, but none of it making use of the normal channel. Viewed from the stomach side the excised septum appeared to be absolutely complete. Two black mattress sutures projected into the lumen of the stomach.

EXPERIMENT XXVIII. April 25, 1913. This repeats Experiment XXVI in every essential.

August 30. A rœntgenogram made this day showed the stomach to have no functionating pyloric portion. Bismuth escaped through the gastro-enterostomy only.

September 4. The dog, well nourished and playful, was killed with chloroform. The lesser peritoneal cavity, posterior to the exclusion line, was partially obliterated. The pancreas was hard and nodular throughout. The aspect of this specimen was altered on account of an anterior gastro-enterostomy having been made. However, a deep furrow extending around the stomach illustrated plainly the location of the new septum. The excluded portion was shrunken though not to the extent apparent in earlier specimens. Postmortem Rœntgen-ray findings indicated that bismuth could not be forced into the pyloric portion of the stomach, but that it passed out only through the newly made opening. Viewed from the stomach side this septum showed an opening on the minor curvature which was 1 cm. in diameter. The persisting obstruction measured from the edge of this opening to the greater curvature was 2 cm. in length. On the greater curvature side no opening could be found for the finest probe. A piece of silk hanging from the last-named area proved that it was the artificial new structure.

It is interesting to note in this connection that the greatly shortened and thickened excluded portion of the stomach failed to propel bismuth through the pylorus, although admitting a small amount into its own cavity, the septum being incomplete. This is shown by a radiogram taken four months after the operation as well as by another taken after the stomach had been removed from the body and injected with bismuth under pressure.

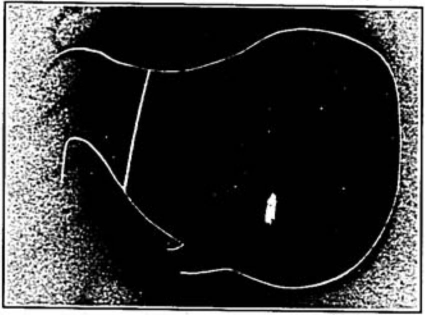

FIG. 15.—This is a roentgenogram taken during life four months after the operation. It shows bismuth leaving the gastro-enterostomy opening but none entering the pyloric region.

EXPERIMENT XXIX. May 1. This experiment essentially repeated Experiment XXVI.

August 30. The functional absence of its pyloric portion was apparent in a rœntgenogram (Fig. 15) of this stomach. Bismuth escaped only through the gastro-enterostomy opening. A deep groove, particularly well marked on the anterior surface of the stomach, showed the pyloric portion so shrunken as to be almost unrecognizable, the pyloric ring having been drawn to within 2 cm. of the exclusion line. Postmortem Rœntgen rays (Fig. 16) showed no bismuth passing through the excluded portion, but it left the stomach freely *via* the gastro-enterostomy opening. Viewed from the stomach side this septum presented an irregular opening about 8 mm. by 3 mm. in size. This was toward the greater curvature. The rest of the septum was intact and presented two long silk threads hanging free in the stomach cavity.

EXPERIMENT XXX. May 3. This was an exclusion similar to Experiment XXVI.

The dog, which died June 9, was very thin. The autopsy showed no peritoneal involvement, the gastro-enterostomy having been made by mistake into the tranvserse colon. The stomach was small and distorted in a peculiar manner. A deep circular furrow showed

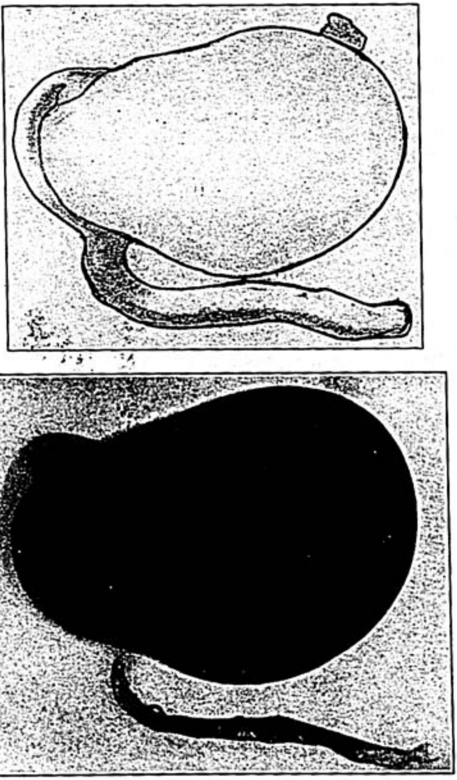

FIG. 16.—This illustrates postmortem appearance in Experiment XXIX.

the point where the exclusion was made. The portion of the stomach excluded preserved, to a certain extent, its outline, but was considerably smaller than at the time of operation, as shown by a postmortem rœntgenogram of the experiment. Viewed from inside the septum appeared to be complete. It was scarcely to be distinguished from the rest of the stomach wall on one side or from the intestine ending blind on the other.

Experiment XXXI. June 6, 1913. This experiment was carried out similar to Experiment XXVI.

June 30 the dog died. Little can be stated definitely about this stomach, since it was removed by one of the other men in the surgical department and not hardened while distended.

Experiment XXXII. June 10. This is a repetition of Experiment XXVI.

June 23 the dog died but was destroyed by mistake.

Experiment XXXIII. November 10. One-fifth of this animal's stomach was excluded by the method used in Experiment XXIII, the partial division of the viscus being made by actual cautery.

January 27, 1914, the dog died. It was emaciated, although nothing discovered at autopsy explained this condition. The peritoneum was practically normal and the exclusion line as well as the gastro-enterostomy opening was practically free from adhesions. The excluded portion was pale and contracted to a fraction of what it had been. A furrow which ran clear around the viscus showed where the exclusion was made. The septum, measured from minor to major curvature extended about 3.5 cm. across and presented an almost round opening approximately 0.75 cm. in diameter. A heavy suture hung into the cavity of the stomach. The edges of this opening were lined with a continuous mucous membrane which united the cavity of the stomach with this shrunken partially excluded pouch.

Experiment XXXIV. April 14, 1914. Here Experiment XXVI was somewhat improved upon. After a skewer was thrust through both stomach walls a long clamp with slit blades (Fig. 12) was applied immediately behind the same; mattress sutures were then introduced, tied, and cut in the "slit" and the skewer burned out with the cautery. After all surfaces were whipped over the slit clamp was removed, the field buried, and the operation completed with a posterior gastro-enterostomy. The animal is still alive.

This is the technique now recommended to other experimenters.

Of the preceding Experiments XXII to XXXIV inclusive the last two mentioned will not be considered, since the time elapsed has not been sufficient to warrant any conclusion. Of the remaining eleven, one dog died on the twelfth and another on the thirteenth day without known cause of death. Another died on the fourteenth day with autopsy wholly negative and another on the seventeenth. Another died on the twenty-fourth day. Two died on the twenty-sixth day with no cause of death ascertainable at autopsy. While I will not endeavor to draw conclusions from results obtained upon a dog which died at thirty-seven days or less, I will merely state that the appearance of the specimens was highly gratifying. In every instance the excluded portion of the stomach was shrunken to a degree which made a striking contrast with its size before the operation. A deep furrow marking the site of operation would make one think that a complete instead of a very incomplete division and suture of the viscus had been made. In none of this last series, Experiments XXII to XXXIV was there a leak nor did autopsy reveal a cause of death which might be traced to the operation as such. The remaining three animals of this group were sacrificed at four, four one-half and six months respectively after Rœntgen-ray examination had shown during life that the pyloric region had been functionally obliterated and that the gastro-enterostomy alone drained the stomach. Nine septa in this group, Experiments XXII to XXXVI, were excised and examined, five of them seeming complete at twelve, fifteen, eighteen, thirty-seven and one hundred eighty-four days respectively. Two twenty-six day specimens were complete with the exception of a cleft so tiny that a faint ray of light penetrated them. The remaining two, examined at one hundred twenty-one and one hundred thirty-two days respectively, showed an opening in each, the largest of these being 1 cm. in diameter. For practical purposes it would seem as though a high degree of obstruction must have resulted when an opening of this size is compared with the original lumen of the stomach at a point some 6 cm. from the pylorus, where the exclusion line was placed. The procedure is remarkably simple where a "skewer" is used, is entirely free from bleeding or soiling, can be quickly accomplished, and apparently gives permanent results.

Experiment XXXV. February 10, 1914. The stomach was partially divided, by the skewer method, into two equal cavities as nearly as this could be ascertained. A low anterior gastro-enterostomy was done and then the stomach was cut transversally in two, very close to the pylorus. The duodenal stump was covered with two rows of sutures and dropped. The open end of the stomach was sutured between the lips of the abdominal wound at its upper angle, the rest of the wound being closed in layers.

February 16 the dog died. The divided pyloric portion of the stomach remained where it had been sutured in the angle of the wound, but the rest of the laparotomy wound was wide open, the animal emaciated and covered with filth.

Experiment XXXVI. February 16, 1914. We did identically the same experiment as that reported in Experiment XXXIV, the animal living but two days, obviously too short a time for any physiological determinations to be made.

February 20, 1914, the dog died of peritonitis.

Experiment XXXVII. February 24, 1914. The stomach was divided transversally at about its middle, and the two resulting ends were closed blind, after which a high gastro-enterostomy was done. An ordinary bone button had been placed in the excluded cavity, and this, with the stomach wall stretched over it, was anchored between the lips of the skin wound by a suture which closed one angle of the rectus sheath incision behind it after anchoring the stomach peritoneum to the skin. The rest of the laparotomy wound was closed in layers.

February 27 the dog died of pneumonia.

So far as gross comparison at the operating table in this experiment goes, transverse section of the stomach does not seem to make any immediate difference in the motility of the excluded half. Peristaltic waves were as strong and as frequent after complete division of the organ as they had been before it.

Experiment XXXVIII. March 10, 1914. The same operation was done as in Experiment XV, the stomach being almost completely divided into two pouches, the greater lying to the left and the lesser representing about one-third of the total capacity. After the lesser pouch had been closed up its lower extremity was sutured to the peritoneum and skin of the upper angle of the wound to be opened later. The remainder of the laparotomy incision was closed in layers and the whole smeared with collodion.

The animal died the day following operation. The excluded portion of the stomach was distended with thin foul-smelling contents, and it was supposed that the animal died of absorption caused by stomach obstruction due to drawing a part of the organ up into the incidion.

It was hoped that Experiments XXXV to XXXVIII inclusive would throw some light on the chemistry of the partially excluded stomach; however, none of the animals survived.

Experiment XXXIX. March 18, 1914. A band of fibrous tissue one-quarter inch wide was stripped from the exact midline embracing all between skin and peritoneum. It was tied transversely around the stomach at about its middle, a silk stitch united the two portions of the band where they crossed, while each free end was fastened to the fibrous ring with one silk stitch. An anterior gastro-enterostomy was done. Sacrificed October 1, 1914. There were no adhesions and the obstruction were complete. The fascial band could not be identified.

Experiment XL. March 24, 1914. An aluminum strip was rolled about the stomach so as to exclude the pyloric one-fourth. The metal was $\frac{5}{16}$ inch wide and 0.04 inch in thickness. The ends overlapped about $\frac{5}{8}$ inch, and were held so only by the stiffness of the material. A posterior suture gastro-enterostomy was done.

EXPERIMENT XLI. March 31, 1914. The same operation was done as in Experiment XXXIX. The metal band being ¼ inch wide and 0.011 inch thick. The ends were rolled over each other so as to catch firmly.

Dogs XL and XLI were sacrificed October 1, 1914, and in each instance the ring was buried in scar tissue and surrounded with unusually strong adhesions. Both stomachs were entirely obstructed the bands *not* having cut through.

A metal band as used by Brewer is surely easy to apply around the stomach, and my two dogs have experienced no ill effects from it, yet I can hardly bring myself to leave a metal foreign body in the peritoneal cavity in view of the fact that similar results are claimed for an autoplasty. It must be added that no published observation of ultimate results dates back longer than two months and ten days.

It has not been proved experimentally that any of the constriction methods are able to permanently exclude a considerable portion of the stomach. My own three experiments are too recent to be of value, and mere pyloric obstruction by this means can have no part in this discussion of exclusion of the pyloric antrum.

The constriction methods all possess the theoretical objection that they leave a folded-up intact mucous membrane, *and therein go contrary to the process of nature in which a destructive process of the inner coats is the first step in the formation of a more or less annular scar which results in the hour-glass stomach.*

As a result of these experiments I have to offer two methods which seem to have been about equally efficient. The one was employed, in principle at least, in Experiments XXII to XXXVI inclusive (see Figs. 9 to 16 inclusive). It is the easier of the two, violates a recognized surgical principal in *leaving mucous membrane between layers which are supposed to heal together*, and while I have been unable to demonstrate that it is dangerous, still I have not the temerity to recommend or advise its further use on the human subject before more similar experiments have been done by others.

The second method referred to was used in Experiments XII to XXI inclusively (see Figs. 3, 4, and 5). It is more difficult, takes a little longer, and encounters more bloodvessels than does the other. Still it employs only time-tried and proven principles hence must be recommended in the absence of further experimental proof to the contrary.

All authors who have had experience with pyloroplasty will bear testimony to the fact that shrinkage and closure are to be feared after an incision into the interior of the stomach. This principle makes the reason for my own experiments apparent and their favorable outcome logical.

During one operation (Experiment XXXVIII)) at least, peristaltic waves were seen to travel uninterrupted the entire length of a stomach which had just been completely divided transversely. This is in line with the thought that gastric motility is governed by automatic centres within the organ, and will furnish food for thought to those who write of "placing the ulcer-bearing area at rest" by various simple methods.

Conclusions. 1. My first ten experiments demonstrate that almost any form of operation which removes a cuff of mucosa plus submucosa, with approximation of denuded muscular coats, results in the formation of a diaphragm. Blind suture closure of the layers from which a section has been removed seems a necessary safeguard. However, none of these methods is considered simple or safe enough to warrant use on the human subject.

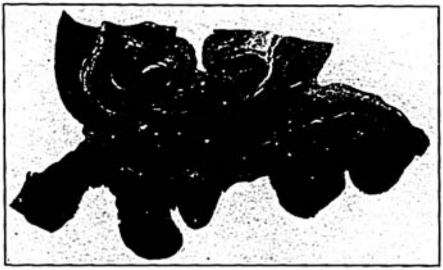

**Fig. 17.**—Illustrates cross-section of the septa obtained as a result of fourteen experiments done by the two methods proposed in this paper.

2. My results detailed in the body of this article, as well as those obtained on ten human subjects (reported at 1914 meeting of the American Medical Association) seem to indicate that both of my incomplete exclusion methods, Experiments XI to XXXIV inclusive, accomplish practically what the more difficult Doyen-von Eiselsberg procedure does: cognizance being taken of the fact that I have no animal observation more remote than two hundred and ten days (Fig. 17 illustrates cross-section of the septa obtained). One advantage which cannot be denied these forms of exclusion is that no prolapse of the major portion of the stomach is possible with subsequent functional disturbance, since the organ is not completely divided nor the two halves detached from each other.

3. The pyloric antrum was found to undergo a surprising diminution in its size after partial exclusion no matter what technique was used. This would seem to be due to tonic muscle contraction,

since comparison with control specimens from the pyloric antrum of a normal stomach shows the excluded muscularis to be greatly thickened. Histological study of many sections from the areas effected in eighteen experiments demonstrates no other abnormality.

6. I will go no farther than to suggest that the obstruction may have been of *functional* nature in stomachs which were cut only half way across, found at autopsy to possess an incomplete septum, and showed tonic contraction of the excluded area.

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# GASTRIC HEADACHES.

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Headaches of any kind are a great affliction; but they are so common and so rarely serious in their consequences, they often recur throughout so many years of life without inducing fatal results, that they do not receive the same consideration by the profession as do other and more threatening ailments. After excluding cerebral neoplasm and meningitis, chronic nephritis and arteriosclerosis it is too often the physician's custom to assure the patient that his headaches are of no consequence and need cause him no alarm; while if any treatment at all is given, it is frequently empirical, without any definite conclusion as to the cause of the paroxysms or rational effort to prevent their recurrence.

It is the object of this paper to call attention to headaches due to disturbance of the stomach; to the fact that they are not an infrequent occurrence; that they present characteristics which fairly well identify them; that it is possible by stomach investigation in these cases to prove the existence of gastric disorder, as well as by other examinations to exclude disease elsewhere; and that the headaches can be made to disppear by therapy directed to the underlying gastric disturbance. If these facts are not universally accepted, it is probably because the matter cannot be satisfactorily explained. It is difficult to understand how disorder